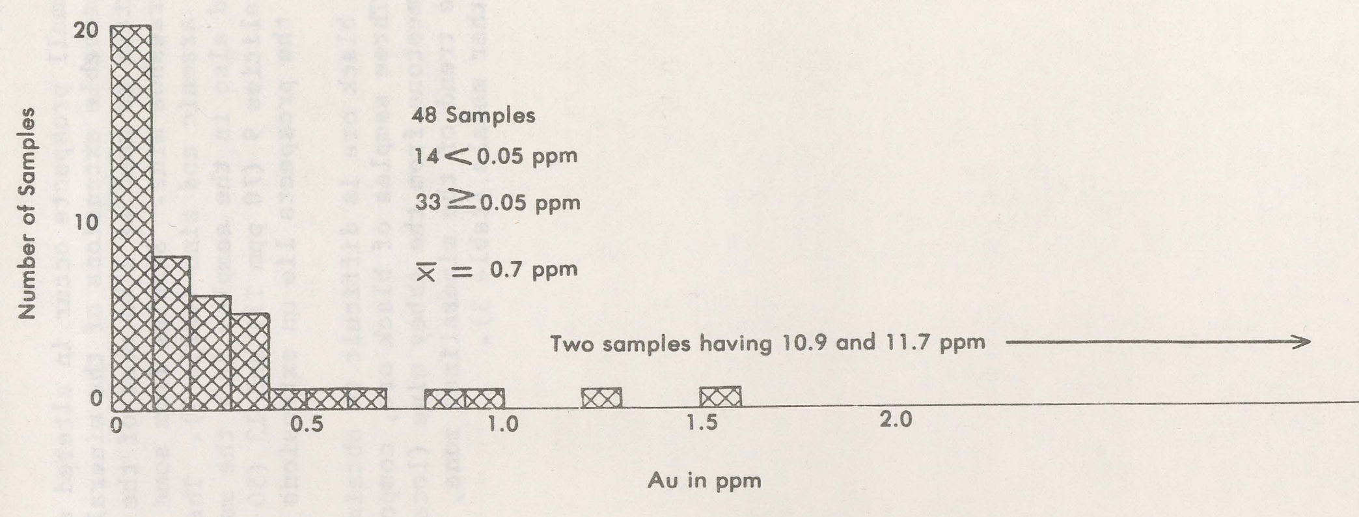

Figure 1.--Gold content of limestone breccia from open pits in mineralized zone, Kendall district.

(2.7-480 ppm), mercury (0.01-1.25 ppm), silver (<0.5-20 ppm), copper (<1-20 ppm), molybdenum (<3-5 ppm), lead (<10-200 ppm), zinc (27-425 ppm), and tellurium (<20-300 ppm). A single grab sample of oxidized syenite porphyry from the Kendall open pit contained 0.40 ppm gold but only traces of other metals (table 3).

Numerous small prospects occur in altered syenite porphyry and limestone breccia along probable extensions of the mineralized zone; they indicate that the zone may extend as much as 2 km west of the Kendall mine and 1 1/2 km north of the Horseshoe mine. Samples from some of the prospects contained anomalous gold, arsenic and zinc (table 3). The presence of anomalous tellurium, noted also in the samples from the main part of the Kendall zone, at prospect localities 9 (70 ppm Tl) and 13 (50 ppm Tl), supports the conclusion that the prospects lie on extensions of the Kendall zone.

Unoxidized black ore is difficult to obtain because most of the mines are inaccessible. Three samples of black ore, composed of fine-grained carbonaceous limestone from the Abbey mine (locality 8), located 1 1/2 km north but on the trend of the mineralized zone, contained 0.32-1.43 ppm gold, but almost no other metals (table 3).

TABLE 3.--Metal content of mineralized rock from the Kendall open pit, Abbey mine, and selected prospects in the Kendall mineralized zone

[Analyses are of grab samples from mine and prospect walls and prospect dumps; gold by fire assay and atomic absorption spectrometry by J. G. Frisken, J. G. Crock, A. W. Haubert, and Joseph Haffty; other elements by six-step semiquantitative spectrographic method by R. T. Hopkins, S. W. Day, M. J. Malcolm, and J. C. Hamilton; leaders (--) indicate no data; N, not found; L, trace amount near limit of detection; limits of detection in ppm are: Au, 0.05; Ag, 0.5; As, 500; Cu, 1; Mo, 3; Pb, 10; Zn, 200]

Sample no.	Map location	Source and description of sample	Analyses in parts per million						
			Au	Ag	As	Cu	Mo	Pb	Zn
M-22	7	Kendall open pit, brecciated limestone	N	N	N	N	N	30	N
M-23	7	do.	N	N	N	5	N	30	N
M-24	7	do.	0.15	N	N	7	N	15	N
M-25	7	Kendall open pit; kaolinitic syenite porphyry	0.40	N	700	30	N	30	N
Ab-1	8	Abbey mine; in crosscut below surface, carbonaceous limestone	1.43	--	--	--	--	--	--
Ab-2	8	do.	0.32	N	N	3	N	N	N
Ab-3	8	do.	0.45	--	--	--	--	--	--
Ab-4	8	Abbey mine; ferruginous brecciated sandstone	0.45	N	N	5	N	10	N
K-185B	9	Prospect, ferruginous Kibbey Formation	N	N	1,500	30	N	10	N
K-194	10	Caved shaft, ferruginous Kibbey Formation	N	N	1,500	10	N	70	700
K-214	11	Prospect, ferruginous brecciated limestone of Madison Group	N	N	N	70	N	500	1,000
K-216B	12	Prospect, altered ferruginous syenite porphyry	0.16	N	15,000	20	7	15	300
K-248B	13	Prospect, altered breccia of Madison Group and syenite porphyry	0.21	N	N	20	N	50	N

Breccia pipes--Mineralized breccia pipes occur at the head of Plum Creek in the North Moccasin Mountains, on Tower Peak in the South Moccasin Mountains, and at the Republic claim on the Hanover dome. Each was mapped and sampled in reconnaissance fashion to determine the nature and extent of mineralized rock. The breccias at Plum Creek and Tower Peak are in syenite porphyry and consist mainly of syenite matrix; the Republic breccia intrudes Colorado Shale and consists mainly of shale matrix. All breccias contain fragments of syenite porphyry, sedimentary rocks of various ages, biotite schist of Precambrian age, and a few mineralized rocks containing galena, pyrite, and sphalerite. Similar fragments of mineralized rock occur in small dikes of quartz monzonite porphyry of Tower Peak. The breccias differ from the diatremes of northern Montana described by Hearn (1979) in that they do not contain fragments of, and are not associated with, mafic alkalic rocks. The breccia pipes formed by venting of magmatic fluids after intrusion of the main mass of syenite porphyry; upward venting was followed by downward suction into the void left by escaping fluids, so that formations above and below the syenite porphyry are represented among the breccia fragments.

Hydrothermal alteration and mineralization of the breccias after emplacement has been weak, but is evident from sparsely disseminated pyrite, fracture coatings of secondary copper minerals, and minor development of sericite in the breccia matrix. The Republic breccia pipe contains veinlets of well-crystallized kaolinite. The Plum Creek breccia pipe is adjacent to an equally large crackle zone in syenite porphyry; the crackle zone contains disseminated pyrite, quartz veinlets, and minor sericite. The Tower Peak breccia pipes are mostly surrounded by an area of bleached syenite porphyry; the nature of the bleaching has not been investigated. Analyses for gold and other metals (table 4) show that all of the pipes are mineralized.

TABLE 4.--Range and mean content of selected metals in breccia pipes and associated altered rocks of the North and South Moccasin Mountains

[Gold analyzed by fire assay and atomic absorption spectrometry by P. H. Briggs; all other metals analyzed by spectrographic methods by J. C. Hamilton. Leaders (--) indicate not enough samples are above limit of detection to compute a geometric mean. ND indicates no data]

Metal and limit of detection in ppm	Plum Creek breccia pipes and crackle zone (32 samples)		Tower Peak breccia pipes and bleached zone (7 samples)		Republic breccia pipe (6 samples)	
	Range in ppm	Geometric mean in ppm	Range in ppm	Geometric mean in ppm	Range in ppm	Geomtric mean in ppm
Au (0.05)	<0.05-4.11	--	ND	ND	<0.05-0.50	--
Ag (0.5)	<0.5-30	--	<0.5	--	<0.5-200	2
Cu (1)	3-150	20	3-30	8	30-1,500	130
Mo (3)	<3-70	3	<3-7	--	<3-150	--
Pb (10)	15-1,000	49	20-70	42	30->20,000	500
Zn (200)	<200-300	--	<200-500	--	<200-100,000	1,500

The pipe judged most likely to be associated with metal deposits is that on Plum Creek. The Plum Creek breccia pipe is the largest of the pipes in the Moccasin Mountains; it is adjacent to a quartz-filled crackle zone which, although weakly developed, resembles those associated with many molybdenite deposits; and it contains anomalous although scattered traces of gold, silver, copper, molybdenum, lead, and zinc. Gold was detected in only five of 32 samples analyzed; highest values (3.19 and 4.11 ppm) are from prospects along the east side of the breccia pipe. As much as 70 ppm Mo and 1,000 ppm Pb occur at the surface. All analyzed samples were collected from weathered rock, so that the surface anomaly of metals other than gold may be much diminished from original values. The absence of highly differentiated intrusive rock at the surface and the general lack of advanced (phyllic and potassic) alteration, however, indicates that the surface exposure of the pipe may be well above any significant ore deposits. The Tower Peak breccia pipes are small and contain only slightly anomalous traces of metals, suggestive of low mineral potential. The mineral potential of the Tower Peak area may be more favorable than the low geochemical anomalies indicate, however, because the pipes are associated with an intrusive complex that has undergone chemical differentiation. The Republic breccia pipe contains locally high concentrations of metals, but these are attributed to pre-breccia mineralized fragments. The pipe must be far from its source, which lies beneath the Hanover dome, inasmuch as it has penetrated a thick sequence of sedimentary rock.

Scattered Prospects.--Numerous prospects occur outside the mineralized zone of the Kendall area and the breccia pipes; many are near contacts of igneous and sedimentary rocks. Gold, pyrite, fluorite, galena, and sphalerite are present in some of these prospects and are reflected in analyses of the metal content of grab samples from the prospects (table 5). Mineralized rock exposed in many of the prospects is too oxidized, however, to permit recognition of sulfide minerals.

Some localities in the South Moccasin Mountains have altered host rocks, gold, and other metal values that suggest a resemblance to the mineralized zone at Kendall (table 5). Two of these localities, numbers 35 and 38 (Golden and Dawes), have anomalous tellurium (150 ppm Tl at number 35; 70 ppm Tl at Golden and Dawes). The gold and fluorite-bearing sample from Golden and Dawes contains abundant vanadium (1000 ppm); vanadium is probably present in roscoelite, which occurs also at the Spotted Horse mine in the Judith Mountains.

TABLE 5.--Metal content of mineralized and altered rocks, mostly from prospects, exclusive of Kendall mineralized zone and breccia pipes

[Analyses are of grab samples from prospect walls and dumps; gold by fire assay and atomic absorption spectrometry by J. G. Crock, A. W. Haubert, and Joseph Haffty, other elements by six-step semiquantitative spectrographic method by J. C. Hamilton; N, not found; L, trace amount near limit of detection; limits of detection in ppm are: Au, 0.05; Ag, 0.5; As, 500; Cu, 1; Mo, 3; Pb, 10; and Zn, 200]

Sample no.	Map location	Source and description of sample	Analyses in parts per million						
			Au	Ag	As	Cu	Mo	Pb	Zn
		North Moccasin Mountains							
K121	14	Prospect, ferruginous syenite porphyry	0.06	N	N	50	N	15	N
K173A	15	-do-	0.08	1.5	N	200	N	50	N
K173B	15	Caved adit, pyrite- and epidote-bearing Pilgrim Limestone	2.17	70	N	2,000	3	20	700
K224A	16	Prospect, altered ferruginous syenite porphyry	N	N	N	7	N	30	N
K232	17	Outcrop of pyritic shale, Cambrian undivided	N	N	N	100	N	15	N
K243	18	Roadcut, altered pyritic syenite porphyry	N	N	N	1.5	N	15	N
K260B	19	Caved adit, pyritic Pilgrim Limestone	N	1.5	N	7	N	70	N
K291	20	Outcrop above prospect; altered, brecciated, ferruginous Flathead Quartzite	N	N	N	5	N	N	N
K322	21	Prospect, ferruginous syenite porphyry	0.08	1	N	5	N	30	N
K326	22	Caved adit; pyrite- and chalcopyrite-bearing syenite porphyry	0.06	N	N	150	5	15	N
K327	23	Prospect, altered syenite porphyry	N	7	N	150	30	2,000	N
		South Moccasin Mountains							
S340	24	Prospect, fluorite veinlets in Madison Group	N	20	N	70	7	500	N
S342	25	-do-	N	7	N	50	3	30	N
S343	26	-do-	N	3	N	15	N	50	N
S345	27	Quarry, clear calcite in Madison Group	N	N	N	10	N	15	N
S345B	27	Quarry, pyritic limestone of Madison Group	0.23	200	N	200	N	1,000	1,000
S428B	28	Prospect, altered fluorite-bearing breccia	N	1.5	N	20	N	500	N
S429	29[1/]	Outcrop, ferruginous sedimentary rock	N	1.5	1,500	20	N	150	300
S430A	30[1/]	Caved adit, ferruginous limestone	0.53	15	N	100	7	1,500	300
S430B	30[1/]	-do-	N	N	N	15	N	20	1,500
S438AB	31	Prospect, altered quartz monzonite porphyry	0.21	N	1,000	50	7	70	300
S446	32[1/]	Prospect, silicified ferruginous sedimentary rock	0.18	50	N	700	N	1,000	20,000
S494	33	Caved adit, Lead Chief No. 1, ferruginous breccia	0.63	200	1,500	1,500	15	>20,000	100,000
S533	34[1/]	Outcrop below adit, ferruginous limestone of Madison Group	N	N	L	20	150	200	1,500
S566	35	Prospect, pyrite-bearing inclusions in quartz monzonite porphyry dike	N	N	N	10	N	300	N
S649	36[1/]	Federal Reserve prospect, ferruginous limestone breccia from Madison Group	0.56	70	20,000	30	7	5,000	7,000
77C19	37	Prospect, galena- and fluorite-bearing ferruginous limestone	0.59	300	1,500	3,000	N	>20,000	100,000
77C20	38[1/]	Caved adit, Golden and Dawes mine, fluorite-bearing altered limestone breccia of Madison Group	4.10	30	N	50	N	1,500	N
M-1	39	Whiteware kaolin open pits, kaolinized mudstone of Kootenai Formation	N	N	N	N	N	30	N
M-2	39	Whiteware kaolin open pits, silicified and kaolinized sandstone of Kootenai Formation	N	N	N	30	N	10	N
M-3	39	Whiteware kaolin open pits, ferruginous breccia	N	N	700	10	N	30	N

[1/] Prospects in mineralized rock that resembles Kendall zone.

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